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C-clamp and pelvic packing for control of hemorrhage in patients with pelvic ring disruption

Lustenberger, T ; Meier, C ; Benninger, E ; Lenzlinger, P M ; Keel, M J B

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DOI: <https://doi.org/10.4103/0974-2700.86632>

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ZORA URL: <https://doi.org/10.5167/uzh-59849>

Journal Article

Published Version

Originally published at:

Lustenberger, T; Meier, C; Benninger, E; Lenzlinger, P M; Keel, M J B (2011). C-clamp and pelvic packing for control of hemorrhage in patients with pelvic ring disruption. *Journal of Emergencies, Trauma, and Shock*, 4(4):477-482.

DOI: <https://doi.org/10.4103/0974-2700.86632>



Journal of Emergencies, Trauma, and Shock

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C-clamp and pelvic packing for control of hemorrhage in patients with pelvic ring disruption

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ABSTRACT

Background: Exsanguinating hemorrhage is the major cause of death in patients with pelvic ring disruption. **Aims:** The aim of this study was to document outcomes after the stabilization of pelvic ring injuries by a C-clamp and control of hemorrhage by pelvic packing. Physiological parameters were tested as prognostic factors. **Setting and Design:** This was a retrospective study at a level I trauma center. The study period was from January 1996 to December 2007. **Materials and Methods:** Fifty patients with pelvic ring disruption and hemorrhagic shock were analyzed. The pelvic rings were fixed by a C-clamp, and patients with ongoing hemorrhage underwent laparotomy and extra- and/or intra-peritoneal pelvic packing. Clinical parameters (heart rate, mean arterial pressure) and physiological parameters (lactate levels, hemoglobin, hematocrit) were documented at admission and at different time points during the initial treatment (1, 2, 3, 4, 6, 8, and 12h after admission). **Results:** Within 12 h of admission, 16 patients died (nonsurvivors) due to hemorrhagic shock ($n=13$) or head injuries ($n=3$). In this group, 12 patients underwent laparotomy with pelvic packing. Thirty-four patients survived the first 12 h (early survivors) after fixation by a C-clamp and additional packing in 23 patients. Four of these patients died 12.3 ± 7.1 days later due to multiple organ failure ($n=3$) or severe head injury ($n=1$). The blood lactate level at admission was significantly higher in the group of nonsurvivors (7.2 ± 0.8 mmol/L) compared to the early survivors (4.3 ± 0.5 mmol/L, $P<0.05$). While hemoglobin values improved within the first 2 h in nonsurvivors, lactate levels continued to increase. **Conclusion:** Pelvic packing in addition to the C-clamp fixation effectively controls severe hemorrhage in patients with pelvic ring disruption. Early sequential measurements of blood lactate levels can be used to estimate the severity of shock and the response to the shock treatment.

Key Words: C-clamp, hemorrhage, lactate, pelvic injury, pelvic packing

INTRODUCTION

In multiply injured patients with pelvic ring disruptions, exsanguinating hemorrhage represents the major cause of death within the first 24 h after injury. Despite advances in management,

the mortality rate in these patients remains high. Starr *et al.* reported 57% mortality for patients with pelvic fractures and hemorrhagic shock upon arrival at the hospital.^[1] A similarly high mortality rate of 40% was found by Smith *et al.* in pelvic fracture patients requiring six or more units of red blood cells to be transfused within 12 h of injury.^[2] Biffl *et al.* reported a decrease of the overall death rate from 31% to 15% in hemodynamically compromised patients with pelvic fractures over a 6-year period; this decrease reflects a more effective multidisciplinary clinical pathway in the later period.^[3]

An immediate identification of bleeding severity and dynamics in the early resuscitation period is critical in these patients.^[4,5] It is well known that young patients in particular are able to compensate for severe blood loss over several hours without significant changes in arterial blood pressure, central venous

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10.4103/0974-2700.86632

pressure, hemoglobin, or hematocrit. Previous studies have shown that the use of hemoglobin and hematocrit values alone may lead to fatal underestimation of the true hemodynamic status because they do not show any significant correlation with cellular perfusion and regional tissue oxygenation.^[6,7] Traditional vital signs such as blood pressure and heart rate (HR) are not very sensitive in terms of detecting hemorrhage.^[7] In our previous work, we therefore suggested that blood lactate levels and kinetics might be more appropriate parameters for diagnosing hemorrhage severity and for evaluating the efficacy of a therapy.^[8]

The optimal acute treatment of patients with pelvic ring disruption is still under discussion. In order to control hemorrhage, the displaced pelvic ring injury must rapidly be reduced and stabilized by a pelvic binder, an external fixator, or a pelvic clamp. However, additional methods to control hemorrhagic shock are more controversial, and several techniques have been recommended. The use of angiography with arterial embolization has increased during the last decade as a therapeutic alternative to surgery; this technique has mainly been incorporated in management algorithms in the United States.^[9] Some reports have noted high angioembolization success rates in carefully selected patient groups.^[9,10] Several reports have proposed pelvic packing after external fixation; this is performed mainly in European centers.^[4,8,11] In a previous study, we reported our experience in 14 patients undergoing C-clamp application followed by emergency laparotomy with transabdominal pelvic packing for control of hemorrhagic shock.^[8] Immediate posterior pelvic ring stabilization by a C-clamp provided mechanical stability for pelvic tamponade and resulted in an effective control of hemorrhage.

The aim of the present study was to investigate the outcome after initial C-clamp application and subsequent laparotomy and extra- and/or intra-peritoneal pelvic packing in a larger cohort of patients with ongoing retro- or pre-peritoneal bleedings. We also analyzed the blood lactate level as a diagnostic parameter for identifying hemorrhage and compared this parameter to the parameters hematocrit and hemoglobin.

MATERIALS AND METHODS

From January 1, 1996, to December 31, 2007, 50 consecutive polytraumatized patients with pelvic ring disruption were admitted to our level I trauma center. Inclusion criteria were hospital admission within 24 h of injury, an Injury Severity Score (ISS) of ≥ 17 points, an unstable pelvic ring fracture according to the AO classification (AO B1/2, C1/2/3),^[12] and hemodynamic instability on admission or during any time point of the early resuscitation process. We included patients in whom the dislocation of the pelvic ring had to be reduced and maintained by external fixation using a pelvic C-clamp. Patients with primary definitive osteosynthesis or primary angiographic embolization were excluded.

All patients presenting with pelvic ring injuries underwent management according to our institutional protocol for pelvic

injuries. The evaluation of the trauma pattern and treatment followed the Advanced Trauma Life Support (ATLS®) guidelines.^[13] Focused assessment sonography for trauma (FAST) was performed in the emergency room upon arrival. Further assessment included plain radiographs of the chest and pelvis. Concomitant brain, chest, and/or abdominal injuries were evaluated by a CT scan, except for patients with initial severe hemorrhagic shock. In 21 of the 50 patients enrolled in this study, CT scanning could not be performed before emergency treatment due to hemodynamic instability. For early mechanical stabilization of the pelvis, a pelvic binder was applied in the prehospital phase or immediately on arrival. In the case of hemodynamic instability or severe fracture dislocation diagnosed on pelvic X-ray or CT scan, an external pelvic fixation using a pelvic C-clamp was performed in the emergency department or in the operation room. An additional anterior supra-acetabular external fixator was applied in patients with severe disruption of the pubic symphysis and in patients with severe, overlapping pubic rami fractures. In patients with persistent hemodynamic instability due to ongoing hemorrhage, laparotomy and extra- and/or intra-peritoneal packing, or even additional resuscitative thoracotomy, was performed. Associated injuries were treated according to damage control principles. Thereafter, the patient was moved to the intensive care unit, where ongoing core rewarming, correction of coagulopathy, fluid resuscitation, and optimization of the hemodynamic status were carried out. The removal of pelvic or abdominal packing was undertaken within 24 h after trauma or if ongoing or recurrent bleeding was suspected.

Data collected retrospectively included patient demographic information, cause of injury, pelvic fracture pattern, injury severity using the abbreviated injury scale (AIS) score for each anatomic region and the ISS. The severity of hemorrhagic shock at admission was defined according to ATLS® guidelines.^[14] The number of packed red blood cells (PRBC), fresh frozen plasma (FFP), and platelet units transfused was abstracted. Clinical, physiological, and laboratory parameters [HR, mean arterial pressure (MAP), lactate level, hemoglobin, and hematocrit] at admission and at various time points during initial treatment (1, 2, 3, 4, 6, 8, and 12 h after admission) were recorded.

Statistical analysis

Patients who survived for at least 12 h after admission were categorized as early survivors, whereas those who died within 12 h of admission were termed nonsurvivors. The groups were compared using the Mann–Whitney test for continuous variables. Continuous data were reported as the mean \pm standard error of the mean (SEM). Differences were considered significant for $P < 0.05$. All statistical analyses were performed using the SPSS software package (SPSS 12.0; SPSS Inc., Chicago, IL, USA).

RESULTS

Patient data

The study included 26 men and 24 women. The average age of the 50 patients enrolled in this study was 44.7 ± 2.6 years with

an ISS of 41.7 ± 1.6 points and an Acute physiology and chronic health evaluation (APACHE) II Score of 21.6 ± 1.4 points. In 26 patients, the injuries were the results of traffic accidents involving motor vehicles ($n=11$), motorcycles or bicycles ($n=7$), and pedestrians ($n=8$). Sixteen of the accidents resulted from a fall, 10 of which were suicide attempts. Overall, 20 patients died. The highest mortality rate was found for patients suffering traffic accidents [46.2% ($n=12$)] followed by patients with self-inflicted injuries [40.0% ($n=4$)]. A total of sixteen patients died within 12 h of admission (nonsurvivors) due to hemorrhagic shock ($n=13$) or head injuries ($n=3$). Thirty-four patients survived the first 12 h (early survivors). Four of these patients died 12.3 \pm 3.6 days later due to multiple organ failure (MOF; $n=3$) or severe head injury ($n=1$). Basic patient demographics and associated injuries for the two study groups are presented in Table 1.

According to ATLS®, 29 patients showed severe hemorrhagic shock (class III and IV) at admission, and 21 patients were in mild or moderate hemorrhagic shock (class I and II) at admission and deteriorated thereafter. The mean ISS was 43.3 ± 1.9 and 39.8 ± 2.5 for patients in severe and mild/moderate hemorrhagic shock, respectively ($P=0.117$). All nonsurvivors initially presented with severe hemorrhagic shock, compared to 13 patients in the early survivor group. Analyses of the pelvic fractures revealed 8 type B and 42 type C fractures according to the AO classification.^[12] Associated intra-abdominal or urogenital injuries were found in 32 patients. The organs most commonly injured were the liver ($n=12$), the hollow viscus ($n=11$), the spleen ($n=9$), and the bladder ($n=7$; Table 2).

To control hemorrhage, 40 patients underwent laparotomy; 35 of these patients received pelvic packing. In 10 patients, the aorta had to be cross-clamped for hemodynamic stabilization. Additional resuscitative thoracotomy was performed in seven patients in response to absent vital signs [Table 3]. Twenty-two patients required repair of intra-abdominal and/or urogenital organ lesions during emergency operation. In patients undergoing laparotomy, the source of bleeding was venous in 35 cases, whereas arterial bleeding was identified in 5 cases. Additional embolization was not necessary in patients who survived initial treatment with pelvic packing.

A detailed description of the blood components transfused within different time frames is provided in Table 4. Nonsurvivors received on average 8.6 ± 2.3 units PRBC during the first hour of admission compared with 1.8 ± 0.7 units PRBC in the early survivor group ($P=0.002$).

The C-clamp was applied within 39.5 ± 2.2 min of admission to the hospital. No C-clamp-related complications, such as nerve or vascular damage, perforations, or infections, were observed in clinical follow-up or in the autopsies. Furthermore, no infectious complications related to the pelvic packing occurred. In five patients, an additional anterior supra-acetabular external fixator was applied during the initial operation. The C-clamp was removed 3.3 ± 0.3 days after admission; definitive stabilization of the pelvic ring was performed on day 3.5 ± 0.5 .

Table 1: Characteristics of early survivors and nonsurvivors with pelvic ring disruption and concomitant severe hemorrhage

	All patients (n = 50) %	Early survivors (n = 34) %	Nonsurvivors (n = 16) %	P value
Age (years), mean \pm SEM	44.7 \pm 2.6	45.3 \pm 3.2	43.7 \pm 4.6	0.60
Age \geq 55 years	31.9 (15/50)	35.5 (11/31)	25.0 (4/16)	0.53
Males	48.0 (24/50)	44.1 (15/34)	56.3 (9/16)	0.55
SBP <90 mmHg	58.0 (29/50)	38.2 (13/34)	100.0 (16/16)	<0.001
GCS \leq 8	59.1 (26/44)	44.8 (13/29)	86.7 (13/15)	0.01
AIS head \geq 3	38.0 (19/50)	32.4 (11/34)	50.0 (8/16)	0.35
AIS chest \geq 3	62.0 (31/50)	55.9 (19/34)	75.0 (12/16)	0.23
AIS abdomen \geq 3	76.0 (38/50)	70.6 (24/34)	87.5 (14/16)	0.29
AIS extremity \geq 3	60.0 (30/50)	58.8 (20/34)	62.5 (10/16)	1.00
ISS, mean \pm SEM	41.7 \pm 1.6	39.7 \pm 2.1	45.9 \pm 1.6	0.06
ISS \geq 25	90.0 (45/50)	85.3 (29/34)	100.0 (16/16)	0.16
APACHE II (points), mean \pm SEM	21.6 \pm 1.4	17.7 \pm 1.5	30.1 \pm 1.3	<0.001

ISS: INJURY SEVERITY SCORE; APACHE: ACUTE PHYSIOLOGY AND CHRONIC HEALTH EVALUATION; SEM: STANDARD ERROR OF THE MEAN; AIS: ABBREVIATED INJURY SCALE; GCS: GLASGOW COMA SCALE; SBP: SYSTOLIC BLOOD PRESSURE

Table 2: Pelvic fracture pattern according to the AO classification and associated intra-abdominal injuries

	All patients (n = 50) %	Early survivors (n = 34) %	Nonsurvivors (n = 16) %	P value
Pelvic fracture type B				
B1	16.0 (8/50)	8.8 (3/34)	31.3 (5/16)	0.092
B2	10.0 (5/50)	2.9 (1/34)	25.0 (4/16)	0.031
	6.0 (3/50)	5.9 (2/34)	6.3 (1/16)	1.000
Pelvic fracture type C				
C1	84.0 (42/50)	91.2 (31/34)	68.8 (11/16)	0.092
C2	44.0 (22/50)	47.1 (16/34)	37.5 (6/16)	0.559
C3	4.0 (2/50)	2.9 (1/34)	6.3 (1/16)	0.542
	36.0 (18/50)	41.2 (14/34)	25.0 (4/16)	0.351
Liver injury	24.0 (12/50)	20.6 (7/34)	31.3 (5/16)	0.486
Hollow viscus injury (small bowel, colon, rectum)	22.0 (11/50)	20.6 (7/34)	25.0 (4/16)	0.728
Splenic injury	18.0 (9/50)	11.8 (4/34)	31.3 (5/16)	0.124
Bladder injury	14.0 (7/50)	17.6 (6/34)	6.3 (1/16)	0.406

Clinical parameters in early survivors versus nonsurvivors

Nonsurvivors had significantly higher HR [Figure 1a] and significantly lower mean arterial pressure (MAP; Figure 1b) in the first 6 h after admission.

Laboratory parameters in early survivors versus nonsurvivors

Lactate levels of the nonsurvivors at admission were significantly higher (7.2 ± 0.8 mmol/L) than those in early survivors (4.3 ± 0.5 mmol/L; $P<0.05$) and continued to increase until death. However, lactate levels of early survivors decreased in the 6 h after admission [Figure 2a].

In contrast, hemoglobin [Figure 2b] and hematocrit [Figure 2c] values at admission were significantly lower in the nonsurvivor group, but were similar in both groups 1 h after resuscitation.

Laboratory parameters in early survivors requiring pelvic packing versus early survivors without pelvic packing

In early survivors, the lactate levels of patients requiring pelvic

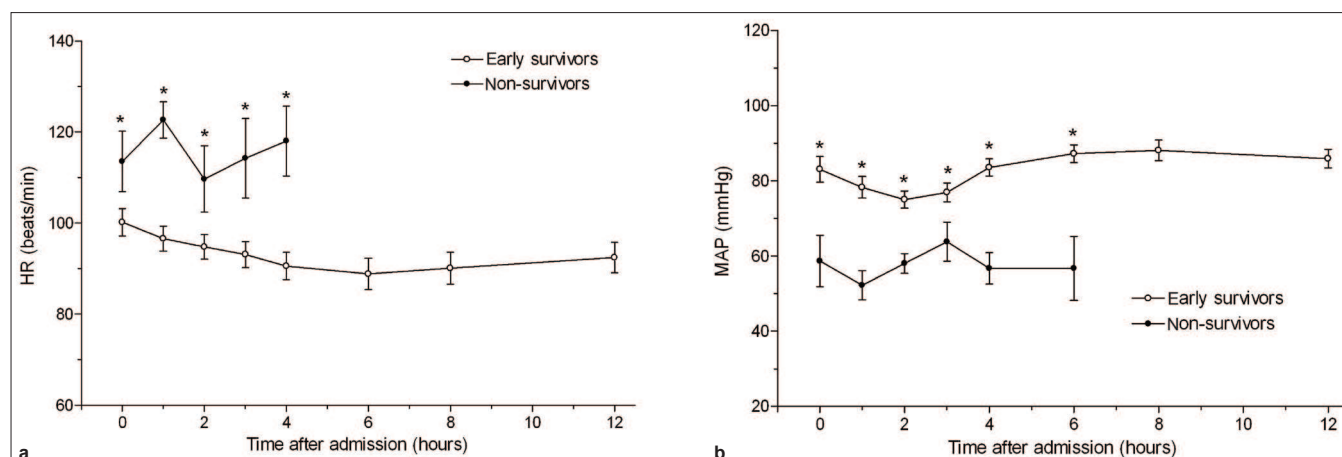


Figure 1: Heart rate and mean arterial pressure in 50 patients with pelvic ring disruption treated with a C-clamp. Heart rate (HR) (beats/min; a) and mean arterial pressure (MAP, mmHg; b) at admission and 1, 2, 3, 4, 6, 8, and 12 h thereafter. Patients who survived the first 12 h after admission (early survivors; $n=34$) were compared with patients who died in the early posttraumatic period (nonsurvivors; $n=16$). * $P<0.05$, early survivors versus nonsurvivors

Table 3: Performed emergency procedures in the two study groups

	All patients ($n = 50$) %	Early survivors ($n = 34$) %	Nonsurvivors ($n = 16$) %	<i>P</i> value
Emergency department thoracotomy	14.0 (7/50)	0 (0/34)	43.8 (7/16)	<0.001
Laparotomy	80.0 (40/50)	76.5 (26/34)	87.5 (14/16)	0.468
Aortic clamping	20.0 (10/50)	5.9 (2/34)	50.0 (8/16)	0.001
Overall pelvic packing	70.0 (35/50)	67.6 (23/34)	75.0 (12/16)	0.746
Intraperitoneal pelvic packing	30.0 (15/50)	17.6 (6/34)	56.3 (9/16)	0.009
Extraperitoneal pelvic packing	68.0 (34/50)	64.7 (22/34)	75.0 (12/16)	0.533
Splenectomy	12.0 (6/50)	5.9 (2/34)	25.0 (4/16)	0.074
Perihepatic packing	24.0 (12/50)	20.6 (7/34)	31.3 (5/16)	0.486
Suturing of hollow viscus injuries	8.0 (4/50)	8.8 (3/34)	6.2 (1/16)	1.000
Resection of hollow viscus injuries without primary anastomosis	14.0 (7/50)	11.8 (4/34)	18.8 (3/16)	0.666
External fixation of extremity fractures	22.0 (11/50)	23.5 (8/34)	18.8 (3/16)	1.000
Intracranial pressure monitoring	14.0 (7/50)	14.7 (5/34)	12.5 (2/16)	1.000

packing ($n=23$) due to ongoing hemorrhage were higher than levels of patients without packing ($n=11$), but decreased within 6 h of admission and normalized (<2 mmol/L) in 19 of the 23 patients within the first 48 h [Figure 3].

DISCUSSION

Patients with pelvic fractures and hemodynamic instability are a diagnostic and therapeutic challenge for every trauma team. The treatment of these patients is controversial. Although most agree that the immediate reduction and external stabilization of the disrupted pelvis is needed, different devices and treatment options have been suggested. There is currently no consensus on how to choose among these possible interventions.^[4] In the United States in particular, pelvic binders are used in prehospital and hospital trauma care for patients with pelvic ring injuries.^[11,15] Comparing pelvic binder and external pelvic fixation in patients with blunt

Table 4: Blood component summary for different time frames comparing early survivors and nonsurvivors

	All patients ($n = 50$)	Early survivors ($n = 34$)	Nonsurvivors ($n = 16$)	<i>P</i> value
PRBC (units)				
0–1 h	4.3±1.1	1.8±0.7	8.6±2.3	0.002
1–2 h	6.7±0.8	5.7±1.0	8.6±1.3	0.115
2–4 h	12.7±1.6	10.2±1.5	19.7±3.2	0.013
FFP (units)				
0–1 h	0.9±0.3	0.2±0.1	2.0±0.8	0.066
1–2 h	5.0±0.7	3.7±0.7	7.2±1.3	0.023
2–4 h	11.1±1.4	8.7±1.1	17.8±2.8	0.006
PLT (units)				
0–1 h	0.2±0.1	0.0±0.0	0.5±0.3	0.414
1–2 h	0.6±0.5	0.0±0.0	1.7±1.2	0.204
2–4 h	7.5±1.6	6.1±1.7	11.7±3.2	0.117

VALUES ARE EXPRESSED AS MEAN±SEM; PRBC: PACKED RED BLOOD CELLS; FFP: FRESH FROZEN PLASMA; PLT: PLATELETS

pelvic fractures, Croce *et al.* demonstrated a reduction in transfusion requirements and the hospital length of stay in the pelvic binder group. However, the two study groups differed significantly in terms of ISS and systolic blood pressure at admission.^[15]

Angiographic embolization is used to control posttraumatic intra- and retroperitoneal bleeding. Velmahos *et al.* reported on 100 patients evaluated by angiography for bleeding from major pelvic fractures or solid visceral organ injuries. In total, 80 patients were embolized due to active contrast extravasation or indirect signs of vascular injury or hemodynamic instability. Angiographic embolization was safe and effective in 95% of these patients.^[9] In a study by Agolini *et al.*, of 806 patients admitted with pelvic fractures, 35 underwent pelvic angiography, and 15 (1.9%) required embolization. Bleeding was successfully stopped in all of the embolized patients.^[10] However, there are still no studies that report the true frequency of arterial bleeding in unstable pelvic fractures. In addition, angiographic embolization is time consuming, and using this technique hinders simultaneous

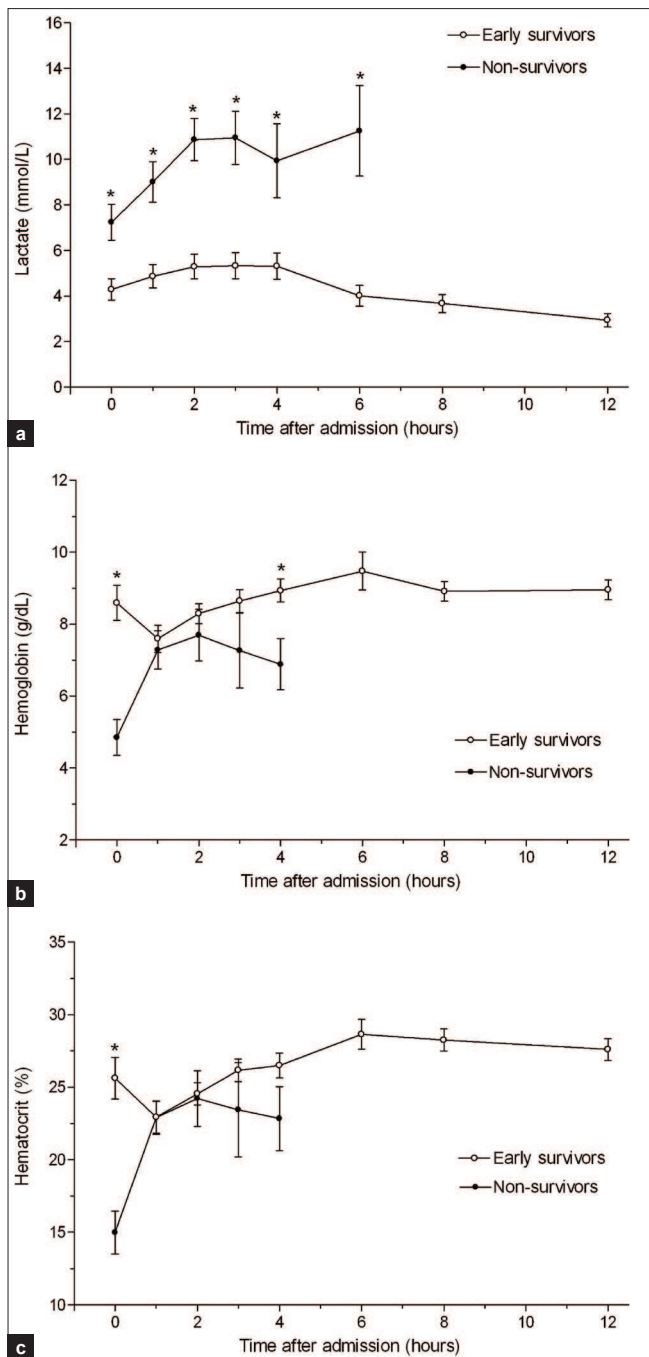


Figure 2: Laboratory parameters in 50 patients with pelvic ring disruption treated with a C-clamp. Lactate (mmol/L; a), hemoglobin (g/dL; b), and hematocrit (%; c) in arterial blood at admission and 1, 2, 3, 4, 6, 8, and 12 h thereafter. Patients who survived the first 12 h after admission (early survivors; $n=34$) were compared with patients who died in the early posttraumatic period (nonsurvivors; $n=16$). * $P<0.05$ early survivors versus nonsurvivors

treatment of other injuries. Thus, in our opinion, angiographic embolization is rarely indicated in patients with unstable pelvic ring fractures and hemodynamic instability. Angiography can be justified only in patients who are hemodynamically stable with arterial bleeding detected by computer tomography or with ongoing hemorrhage after C-clamp application and pelvic packing.

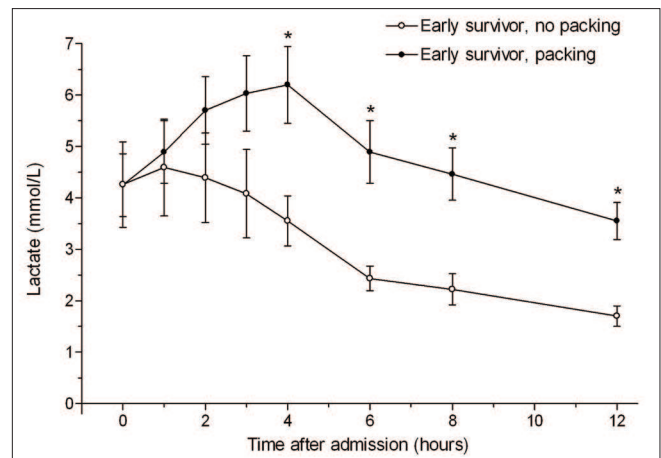


Figure 3: Lactate levels in early survivors requiring pelvic packing compared with early survivors without pelvic packing. Lactate (mmol/L) in arterial blood at admission and 1, 2, 3, 4, 6, 8, and 12 h thereafter. Patients surviving the first 12 h after admission who required pelvic packing ($n=23$) were compared with patients surviving the first 12 h without pelvic packing ($n=11$). * $P<0.05$ early survivors with pelvic packing versus early survivors without pelvic packing

External stabilization by C-clamp, combined with pelvic packing, effectively controls hemorrhage; this is especially true when the major source of bleeding is the fracture site or when the bleeding is venous in origin.^[8,11,16] In a recent retrospective study of 40 hemodynamically unstable patients with pelvic ring fractures, external pelvic fixation in combination with direct retroperitoneal pelvic packing was compared to pelvic angiography. In this series, pelvic packing was as effective as pelvic angiography for hemodynamic stabilization and significantly reduced postprocedure blood transfusion.^[16] In an analysis of 28 patients, Tiemann *et al.* reported their experience using the pelvic C-clamp for emergency treatment of patients with unstable disruption of the posterior pelvic ring. Overall, 7 (25%) patients died. The surviving patients showed blood circulation stabilization as well as consolidation of oxygenation level 6 h after C-clamping. Five hours after the use of the C-clamp, the number of required blood units decreased significantly. However, to avoid damaging the last compartment when opening the retroperitoneum, laparotomy was only performed if blood was confirmed intraperitoneally.^[6] In our study, patients with ongoing hemorrhage, as indicated by persistently elevated lactate levels, underwent surgical bleeding control with pelvic packing. Hemorrhage control was achieved about 6 h after admission, which was clear from the decreasing lactate levels in the surviving patients. Furthermore, the intraoperative findings in most of these patients showed severe damage to ligaments of the pelvic ring, damage to the pelvic floor, or damage to the iliopsoas fascia. Self-tamponade of the retroperitoneum cannot be expected in this situation, and a single external fixation might not be sufficient for effective control of bleeding. During primary laparotomy, a high rate of concomitant intra-abdominal injuries was observed; in 14 patients, surgical repair was performed simultaneously. Taken

together, these results indicate that hemodynamic instability in unstable pelvic fractures is best treated using a combination of surgical hemostasis by C-clamp and pelvic packing in cases with ongoing bleeding.

The early recognition of hemorrhagic shock is fundamental in the management of patients with severe pelvic ring disruption. Hemoglobin and hematocrit have been used in the past for hemorrhage detection and for the estimation of its severity. In our previous work, we demonstrated that hemoglobin and hematocrit are inappropriate parameters for diagnosing shock during the early period after severe pelvic trauma. In contrast, blood lactate levels and kinetics were sensitive parameters for bleeding dynamics and for determining the efficacy of shock therapy.^[8] The results of the present study clearly confirm that hemoglobin and hematocrit are unreliable parameters for estimating acute blood loss or for evaluating the response to shock treatment in the early posttraumatic period. While nonsurvivors presented with significantly lower hemoglobin and hematocrit values at admission compared to early survivors, the values were not significantly different after 1 h of resuscitation. Thus, by using hemoglobin or hematocrit during adequate volume replacement, true resuscitation effectiveness may be overestimated, leading to a fatal outcome. However, blood lactate levels and kinetics seem to correlate better with the outcomes of severely injured patients with pelvic fractures. In patients surviving for 12 h after admission, lactate levels decreased after 6 h of shock and surgical treatment, whereas nonsurvivors showed persistently high lactate levels. This confirms that circulating lactate kinetics are the key in rapidly identifying severe hemorrhage and for monitoring the effectiveness of shock treatment.

This study has several limitations, the most important being the retrospective nature of the data collection and analysis. Furthermore, as in any long-term study spanning more than a 10-year inclusion period, advances in transfusion practices and critical care medicine may have influenced subsequent outcomes.

CONCLUSION

Pelvic packing in addition to C-clamping effectively controls severe hemorrhage in patients with pelvic ring disruption. Early sequential measurements of blood lactate levels are helpful in estimating the severity of hemorrhagic shock and the response to shock treatment.

ACKNOWLEDGMENT

The authors are indebted to Prof. Dr. Dr. h. c. Otmar Trentz for his commitment, teaching, and support as director of the Division of Trauma Surgery, Department of Surgery, University Hospital Zurich, in recent years.

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How to cite this article: Lustenberger T, Meier C, Benninger E, Lenzlinger PM, Keel MJ. C-clamp and pelvic packing for control of hemorrhage in patients with pelvic ring disruption. *J Emerg Trauma Shock* 2011;4:477-82.

Received: 29.08.10. **Accepted:** 23.03.11.

Source of Support: Nil. **Conflict of Interest:** None declared.